MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

TECHNICAL SPECIFICATION

EE&QA - 961

Appendix A

Common Work Requirements

ISSUED: **September 15, 2023**

REVISION: **1**

SUBWAY OPERATIONS DIRECTORATE
EQUIPMENT ENGINEERING AND QUALITY ASSURANCE

Table of Contents

1.0 COMMON WORK REQUIREMENTS: 3
1.1 Non-Destructive Inspection (NDT) 3
1.2 Weld Repairs of Cracks in Fabricated Structures 5
1.3 Weld Repairs of Defects in Castings 7
1.4 Weld Repairs of Mounting Surfaces 9
1.5 Weld Repairs of Clearance Holes 11
1.6 Repair of Threaded Holes 12
1.7 Weld Repairs of Secondary Brackets 14
1.8 Weld Qualifications 15
1.9 Straightening 16
1.10 Stress Relief Heat Treatment 17
1.11 Painting and Corrosion Protection 19
1.12 Grit Blasting 21
1.13 Cleaning and Stripping 21
1.14 Leak Testing 22
1.15 Dimensional Inspection 22
1.16 Electrical Wiring 23
1.17 Electrical Testing 25

1.0 COMMON WORK REQUIREMENTS:

1.1 Non-Destructive Inspection (NDT)

1.1.1 Visual Inspection (VT)

1.1.1.1 The Contractor shall submit a visual inspection procedure as needed prior to beginning any repairs on the vehicle.

1.1.1.1.1 The Contractor shall establish minimum lighting criteria to use during visual inspection.

1.1.1.1.2 Borescope inspection may be used in lieu of direct visual inspection for inaccessible or difficult-to-access locations.

1.1.1.2 VT inspection acceptance/rejection criteria for wear, damage, deformation, corrosion, burning, plating integrity, or other defects shall be proposed by the Contractor for Authority approval.

1.1.1.2.1 Electrical components shall be inspected for damaged or worn insulation, loose or damaged contacts, scorching, illegible or missing wire markers, or other defects impacting serviceability.

1.1.1.3 VT inspection acceptance/rejection criteria for cracks and weld defects shall be as follows:

1.1.1.3.1 Cast base materials: ASTM E125 Type 1 discontinuities with severity level greater than 1 shall be rejected.

1.1.1.3.2 Fabricated Components - Base Material: Indications with a major axis longer than 1/8” shall be rejected.

1.1.1.3.3 Fabricated Components - Welds: Acceptance criteria per AWS D1.1 or other Authority approved industry standard.

1.1.2 Magnetic Particle Inspection (MT)

1.1.2.1 MT inspections shall be performed in accordance with the latest revision of ASTM E709.

1.1.2.1.1 Half wave-rectified alternating current shall be used, sufficient to detect surface and sub-surface defects.

1.1.2.1.2 Adequate magnetic field strength shall be verified by the use of a “pie gage” (Field Strength Indicator).

1.1.2.1.3 The affected area of the truck shall be demagnetized to not more than 5 gausses upon completion of all magnetic particle testing.

1.1.2.2 MT inspection acceptance/rejection criteria shall be as follows:

1.1.2.2.1 Cast base materials: ASTM E125 Type 1 discontinuities with severity level greater than 1 shall be rejected.

1.1.2.2.2 Fabricated Components - Base Material: Indications with a major axis longer than 1/8" shall be rejected.

1.1.2.2.3 Fabricated Components - Welds: Acceptance criteria per AWS D1.1 or other Authority approved industry standard.

1.1.2.3 The inspector performing the inspection shall be certified, qualified to operate the equipment, perform the MT inspection, and evaluate the results in accordance with ASNT SNT-TC-1A, or Authority Approved Alternate.

1.1.2.4 The Contractor shall submit a written MT inspection procedure with acceptance criteria for Authority approval prior to beginning the repairs.

1.1.3 **Dye Penetrant Inspection (PT)**

1.1.3.1 PT inspections shall be performed in accordance with the latest revision of ASTM E165.

1.1.3.2 PT inspection acceptance/rejection criteria shall be as follows:

1.1.3.2.1 Fabricated Components - Welds: Acceptance criteria per AWS D1.1 or other Authority approved industry standard.

1.1.3.2.2 Fabricated Components - Base Material: Indications with a major axis longer than 1/8" shall be rejected.

1.1.3.3 The inspector performing the inspection shall be certified to perform the PT inspection and evaluate the results.

1.1.3.4 The Contractor shall submit a written PT inspection procedure with acceptance criteria for Authority approval prior to beginning the repairs.

1.1.4 **Ultrasonic Inspection (UT)**

1.1.4.1 UT inspections shall be performed in accordance with the latest revision of ASTM A388.

1.1.4.2 UT inspection acceptance/rejection criteria shall be as follows:

1.1.4.3 The inspector performing the inspection shall be certified to perform the UT inspection and evaluate the results.

1.1.4.4 The Contractor shall submit a written UT inspection procedure with acceptance criteria for Authority approval prior to beginning the repairs.

1.2 **Weld Repairs of Cracks in Fabricated Structures**

1.2.1 Except with written Authority approval, this Section is not applicable for stamped or forged parts; parts fabricated from quench and tempered, thermo-mechanically processed, or precipitation hardened materials; bearing surfaces; press-fit surfaces; or any surface that cannot be brought into full conformance with OEM requirements after welding and grinding.

1.2.2 Weld repair of cracks or defects in fabricated structures that are less than 6 inches in length are within the Contractor's scope of work. Cracks longer than 6 inches shall be considered Hidden Damage and the Contractor shall submit a CAP for Authority review and approval.

1.2.3 Cracked or defective welds shall be repaired using weld preparation matching the OEM weld layout.

1.2.4 Cracks shall be prepared for welding by grinding or gouging. The area surrounding the weld joint preparation shall be free from scale, oil, dirt, and other extraneous matter.

1.2.4.1 If air or carbon arc gouging is used for preparation, a minimum of 1/8 inch of material shall be removed from all gouged surfaces by grinding prior to welding.

1.2.5 If the crack occurs in the base material, the joint preparation shall be as follows:

1.2.5.1 If the crack extends through the base material and the root of the weld is accessible, a "double V" joint preparation shall be used, and the weld shall be performed from both sides. The root of the weld shall be chipped, ground, or scarfed clean, and MT inspected prior to welding from the opposite side.

1.2.5.2 If the crack extends through the base material and the root of the weld is inaccessible, a "single V" joint preparation shall be used, extending completely through the base material, and a backing strip shall be used. The backing strip shall be removed after welding and weld qualifications shall be performed using the same backing material as for repair welds. Extreme cases where the backing cannot be removed shall be brought to the Authority's attention prior to preparing the crack.

1.2.5.3 If the crack extends only partially through the base material, a "single V" joint preparation shall be used, and the weld shall be performed from one side only.

1.2.6 If the crack occurs in a weld, the weld shall be completely removed for the entire length of the crack. Joint preparation and welding shall be performed matching the OEM weld layout.

1.2.6.1 Reference the applicable equipment Section for OEM weld layouts.

1.2.7 Regardless of the joint preparation used, MT inspection shall be performed prior to welding to verify that the crack has been completely removed.

1.2.8 The structure being welded shall be held securely during welding to prevent distortion.

1.2.9 Welding shall be performed using flux cored arc welding (FCAW), gas metal arc welding (GMAW), shielded metal arc welding (SMAW) or Authority approved welding process.

1.2.9.1 Welding consumables such as electrode, shielding gas, and backing shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. Welding consumables are subject to Authority review.

1.2.9.2 Preheat and inter-pass temperature shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. In no case shall the preheat temperature be less than 4.5°C (40°F) or the inter-pass temperature exceed 288°C (550°F).

1.2.9.3 Stringer beads shall be used for all welds, limiting side-to-side motion to 5 times the electrode diameter.

1.2.9.4 All welding repairs shall be performed by qualified welders using qualified procedures in accordance with AWS D1.1, D1.3, or other Authority approved industry standard. Pre-qualification and use of pre-qualified welds and welding procedures is not acceptable.

1.2.9.5 Where possible, welding shall be performed in the flat position. All other positions require additional weld and welder qualifications. Vertical welding is permitted only in the up direction.

1.2.10 After completing the root weld pass, MT inspection shall be performed to assure that a sound weld has been made. MT inspection shall be performed after each intermediate weld pass to verify soundness of the weld pass.

1.2.10.1 Defects found during MT shall be removed and repaired using an Authority approved procedure.

1.2.11 The root pass and each intermediate weld pass shall be de-slagged or peened with an air driven hammer until cleaned to bare metal.

1.2.12 All welds shall be cooled in still air. Forced cooling of any pass or completed weldment shall not be permitted.

1.2.13 The completed weld shall be finished by grinding, where applicable. MT and VT shall be performed to identify defects such as cracks, lack of fusion, porosity, slag inclusions, or undercut.

1.2.13.1 Defects found shall be removed and repaired using an Authority approved procedure.

1.2.14 As a final operation, the entire weld and ½ inch of the parent material on each side shall be peened.

1.2.15 Wherever MT inspection is required, VT inspection shall also be performed. For non-ferromagnetic materials such as aluminum alloys, copper alloys, or austenitic stainless steel, PT shall be used in place of MT. All NDT inspection shall be performed.

1.2.16 The Contractor shall submit a weld repair procedure for cracks in fabricated structures for Authority approval prior to welding any parts.

1.3 **Weld Repairs of Defects in Castings**

1.3.1 Weld repair of cracks or defects in cast material that are less than 6 inches in length are within the Contractor's scope of work. Cracks longer than 6 inches shall be considered Hidden Damage and the Contractor shall submit a CAP for Authority review and approval.

1.3.2 Defects shall be prepared for welding by grinding or gouging. The area surrounding the weld joint preparation shall be free from scale, oil, dirt, and other extraneous matter.

1.3.2.1 If air or carbon arc gouging is used for preparation, a minimum of 1/8 inch of material shall be removed from all gouged surfaces by grinding prior to welding.

1.3.3 The joint preparation shall be as follows:

1.3.3.1 If the defect extends through the base material and the root of the weld is accessible, a "double V" joint preparation shall be used, and the weld shall be performed from both sides. The root of the weld shall be

chipped, ground, or scarfed clean, and MT inspected prior to welding from the opposite side.

1.3.3.2 If the crack extends through the base material and the root of the weld is inaccessible, a "single V" joint preparation shall be used, extending completely through the base material, and a backing strip shall be used. The backing strip shall be removed after welding and weld qualifications shall be performed using the same backing material as for repair welds. Extreme cases where the backing cannot be removed shall be brought to the Authority's attention prior to preparing the defect.

1.3.3.3 If the defect extends only partially through the base material, a "single V" joint preparation shall be used, and the weld shall be performed from one side only.

1.3.4 Regardless of the joint preparation used, MT inspection shall be performed prior to welding to verify that the defect has been completely removed.

1.3.5 The casting being welded shall be held securely during welding to prevent distortion.

1.3.6 Welding shall be performed using flux cored arc welding (FCAW) or shielded metal arc welding (SMAW) only.

1.3.6.1 Welding consumables such as electrode, shielding gas, and backing shall be appropriate for the material(s) being welded and the resulting weld deposit shall have a tensile strength exceeding the minimum tensile strength of the base material. Welding consumables are subject to Authority review.

1.3.6.2 Preheat and inter-pass temperature shall be appropriate for the material(s) being welded to prevent cracking or embrittlement of the weld or heat affected zone (HAZ). In no case shall the preheat temperature be less than 4.5°C (40°F) or the inter-pass temperature exceed 288°C (550°F).

1.3.6.3 Stringer beads shall be used for all welds, limiting side-to-side motion to 5 times the electrode diameter.

1.3.6.4 All welding repairs shall be performed by qualified welders using qualified procedures in accordance with ASTM A488. Pre-qualification and use of pre-qualified welds and welding procedures is not acceptable.

1.3.6.5 Where possible, welding shall be performed in the flat position. All other positions require additional weld and welder qualifications. Vertical welding is permitted only in the up direction.

1.3.7 After completing the root weld pass, MT inspection shall be performed to assure that a sound weld has been made. MT inspection shall be performed after each intermediate weld pass to verify soundness of the weld pass.

1.3.7.1 Defects found during MT shall be removed and repaired using an Authority approved procedure.

1.3.8 The root pass and each intermediate weld pass shall be de-slagged or peened with an air driven hammer until cleaned to bare metal.

1.3.9 All welds shall be cooled in still air. Forced cooling of any pass or completed weldment shall not be permitted.

1.3.10 The completed weld shall be finished by grinding, where applicable. MT and VT shall be performed to identify defects such as cracks, lack of fusion, porosity, slag inclusions, or undercut.

1.3.10.1 Defects found shall be removed and repaired using an Authority approved procedure.

1.3.11 As a final operation, the entire weld and ½ inch of the parent material on each side shall be peened.

1.3.12 Wherever MT inspection is required, VT inspection shall also be performed. For non-ferromagnetic materials such as aluminum alloys, copper alloys, or austenitic stainless steel, PT shall be used in place of MT. All NDT inspection shall be performed.

1.3.13 The Contractor shall submit a weld repair procedure for defects in castings for Authority approval prior to welding any parts.

1.4 Weld Repairs of Mounting Surfaces

1.4.1 Except with written Authority approval, this Section is not applicable for stamped or forged parts; parts fabricated from quench and tempered, thermo-mechanically processed, or precipitation hardened materials; bearing surfaces; press-fit surfaces; or any surface that cannot be brought into full conformance with OEM requirements after welding and grinding or machining.

1.4.2 Nonconforming mounting surfaces shall be prepared for welding by machining or grinding. Joint preparation shall allow for sufficient opening to achieve complete fusion at the root of the weld. The mounting location shall be free from scale, oil, dirt, and other extraneous matter.

1.4.3 The structure being welded shall be held securely during welding to prevent distortion.

1.4.4 Welding shall be performed using arc welding or Authority approved welding process.

1.4.4.1 Welding consumables such as electrode and shielding gas, shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. Welding consumables are subject to Authority review.

1.4.4.2 Preheat and inter-pass temperature shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. In no case shall the preheat temperature be less than 4.5°C (40°F) or the inter-pass temperature exceed 288°C (550°F).

1.4.4.3 All welding repairs shall be performed by qualified welders using qualified procedures in accordance with AWS D1.1, D1.3, or other Authority approved industry standard. Pre-qualification and use of pre-qualified welds and welding procedures is not acceptable.

1.4.4.4 Welding shall be performed in the flat position.

1.4.4.5 The Contractor shall demonstrate that the hardness of the weld deposit meets OEM requirements for the part being repaired.

1.4.5 The mounting surface shall be built up by welding to a sufficient thickness that it can be machined or ground flush to achieve a flat, defect-free surface in accordance with all OEM drawing requirements.

1.4.6 All welds shall be cooled in still air. Forced cooling of any pass or completed weldment shall not be permitted.

1.4.7 The entire weld and ½ inch of the parent material on each side shall be peened.

1.4.8 Following any specified heat treatment, the welded mounting surface shall be finished by machining or grinding. The flatness measurement of the mounting location shall be repeated to verify compliance with the specification requirements.

1.4.9 MT and VT shall be performed to identify defects such as cracks, lack of fusion, porosity, slag inclusions, or undercut.

1.4.9.1 Defects found shall be removed and repaired using an Authority approved procedure.

1.4.10 Wherever MT inspection is required, VT inspection shall also be performed. For non-ferromagnetic materials such as aluminum alloys, copper alloys, or austenitic stainless steel, PT shall be used in place of MT. All NDT inspection shall be performed.

1.4.11 The Contractor shall submit a repair procedure for repairing mounting surfaces for Authority approval prior to repairing any parts.

1.5 **Weld Repairs of Clearance Holes**

1.5.1 Except with written Authority approval, this Section is not applicable for stamped or forged parts; parts fabricated from quench and tempered, thermo-mechanically processed, or precipitation hardened materials; or any clearance hole that cannot be brought into full conformance with OEM requirements after welding and machining.

1.5.2 Nonconforming clearance holes shall be prepared for welding by grinding, if necessary. The clearance hole and surrounding area shall be free from scale, oil, dirt, and other extraneous matter.

1.5.3 The structure being welded shall be held securely during welding to prevent distortion.

1.5.4 Welding shall be performed using arc welding or Authority approved welding process.

1.5.4.1 Welding consumables such as electrode, shielding gas, and backing shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. Welding consumables are subject to Authority review.

1.5.4.2 Preheat and inter-pass temperature shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. In no case shall the preheat temperature be less than 4.5°C (40°F) or the inter-pass temperature exceed 288°C (550°F).

1.5.4.3 All welding repairs shall be performed by qualified welders using qualified procedures in accordance with AWS D1.1, D1.3, or other Authority approved industry standard. Pre-qualification and use of pre-qualified welds and welding procedures is not acceptable.

1.5.5 The clearance hole shall be closed by welding, either partially or completely, such that it can be reamed to meet the specification requirements for diameter, circularity, and surface finish.

1.5.6 All welds shall be cooled in still air. Forced cooling of any pass or completed weldment shall not be permitted.

1.5.7 MT and VT shall be performed to identify defects such as cracks, lack of fusion, porosity, slag inclusions, or undercut.

1.5.7.1 Defects found shall be removed and repaired using an Authority approved procedure.

1.5.8 Following any specified heat treatment, the welded hole shall be finished by reaming. The diameter and circularity measurements of the clearance hole shall be repeated to verify compliance with the specification requirements.

1.5.9 Wherever MT inspection is required, VT inspection shall also be performed. For non-ferromagnetic materials such as aluminum alloys, copper alloys, or austenitic stainless steel, PT shall be used in place of MT.

1.5.10 The Contractor shall submit a repair procedure for repairing clearance holes for Authority approval prior to repairing any parts.

1.6 Repair of Threaded Holes

1.6.1 General

1.6.1.1 Except with written Authority approval, weld repairs of threaded holes are not applicable for stamped or forged parts; parts fabricated from quench and tempered, thermo-mechanically processed, or precipitation hardened materials; or any threaded hole that cannot be brought into full conformance with OEM requirements after welding, drilling, and tapping.

1.6.2 Threaded Inserts

1.6.2.1 Where welding repairs are not applicable, or hot work would present an unacceptable risk of deformation or damage to the part, the Contractor may propose the use of threaded inserts to repair damaged threaded holes.

1.6.2.2 The application and type of threaded insert used shall be approved by the Authority on a case-by-case basis.

1.6.2.3 Threaded inserts shall be installed following the manufacturer's installation instructions.

1.6.2.4 Threaded inserts shall be sufficiently locked to prevent undesired movement of the insert.

1.6.2.5 The Contractor shall submit, for Authority review and approval, a procedure for repairing threaded holes using threaded inserts, including requirements for drilling/reaming, tapping, and installing the threaded inserts. The Contractor's procedure shall reference the manufacturer's installation instructions.

1.6.3 Weld Repairs of Threaded Holes

1.6.3.1 Where welding repairs are applicable, nonconforming threaded holes shall be prepared for welding by drilling, reaming, or grinding sufficient to achieve complete weld penetration and a defect-free weld. The clearance hole and surrounding area shall be free from scale, oil, dirt, and other extraneous matter.

1.6.3.2 The structure being welded shall be held securely during welding to prevent distortion.

1.6.3.3 Welding shall be performed using arc welding or Authority approved welding process.

1.6.3.3.1 Welding consumables such as electrode, shielding gas, and backing shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. Welding consumables are subject to Authority review.

1.6.3.3.2 Preheat and inter-pass temperature shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. In no case shall the preheat temperature be less than 4.5°C (40°F) or the inter-pass temperature exceed 288°C (550°F).

1.6.3.3.3 All welding repairs shall be performed by qualified welders using qualified procedures in accordance with AWS D1.1, D1.3, or other Authority approved industry standard. Pre-qualification and use of pre-qualified welds and welding procedures is not acceptable.

1.6.3.4 The threaded hole shall be closed by welding, either partially or completely, such that it can be drilled and tapped to meet the specification requirements for thread profile.

1.6.3.5 All welds shall be cooled in still air. Forced cooling of any pass or completed weldment shall not be permitted.

1.6.3.6 MT and VT shall be performed to identify defects such as cracks, lack of fusion, porosity, slag inclusions, or undercut.

1.6.3.6.1 Defects found shall be removed and repaired using an Authority approved procedure.

1.6.3.7 Following any specified heat treatment, the welded hole shall be finished by drilling and tapping. Checking of the threads using a go/no-go gauge shall be repeated to verify compliance with the specification requirements.

1.6.3.8 Wherever MT inspection is required, VT inspection shall also be performed. For non-ferromagnetic materials such as aluminum alloys, copper alloys, or austenitic stainless steel, PT shall be used in place of MT.

1.6.3.9 The Contractor shall submit a repair procedure for weld repair of threaded holes for Authority approval prior to repairing any parts using this process.

1.7 Weld Repairs of Secondary Brackets

1.7.1 The base material shall be prepared for welding by cutting or grinding. Existing brackets shall be removed from the base material and remaining weld deposit shall be ground flush to the surface. The repair area shall be free from scale, oil, dirt, and other extraneous matter.

1.7.2 Jigs or fixtures shall be used to accurately position secondary brackets. The structure being welded shall be held securely during welding to prevent distortion.

1.7.3 The secondary bracket shall be welded to the base material using weld preparation and joint geometry consistent with OEM requirements.

1.7.4 Welding shall be performed using arc welding or Authority approved welding process.

1.7.4.1 Welding consumables such as electrode, shielding gas, and backing shall be in accordance with OEM requirements, where applicable, AWS D1.1, D1.3, or other Authority approved industry standard. Any welds between carbon or low alloy steel and stainless steel shall be performed using an electrode capable of producing an austenitic stainless steel weld deposit. Welding consumables are subject to Authority review.

1.7.4.2 Preheat and inter-pass temperature shall be in accordance with AWS D1.1, D1.3, or other Authority approved industry standard for the material(s) being welded. In no case shall the preheat temperature be less than 4.5°C (40°F) or the inter-pass temperature exceed 288°C (550°F).

1.7.4.3 All welding repairs shall be performed by qualified welders using qualified procedures in accordance with AWS D1.1, D1.3, or other

Authority approved industry standard. Pre-qualification and use of pre-qualified welds and welding procedures is not acceptable.

1.7.4.4 Where possible, welding shall be performed in the flat position. All other positions require additional weld and welder qualifications. Vertical welding is permitted only in the up direction.

1.7.5 All welds shall be cooled in still air. Forced cooling of any pass or completed weldment shall not be permitted.

1.7.6 MT and VT shall be performed to identify defects such as cracks, lack of fusion, porosity, slag inclusions, or undercut.

1.7.6.1 Defects found shall be removed and repaired using an Authority approved procedure.

1.7.7 As a final operation, all welds and ½ inch of the parent material on each side of the welds shall be peened.

1.7.8 Wherever MT inspection is required, VT inspection shall also be performed. For non-ferromagnetic materials such as aluminum alloys, copper alloys, or austenitic stainless steel, PT shall be used in place of MT.

1.7.9 The Contractor shall submit a repair procedure for replacing secondary brackets for Authority approval prior to repairing any parts.

1.8 **Weld Qualifications**

1.8.1 All welds shall be performed using qualified Weld Procedure Specifications (WPS) in accordance with the requirements of AWS D1.1, D1.3, ASTM A488, or other Authority approved industry standard.

1.8.2 All WPS shall be qualified by the Contractor or Subcontractor who will be performing the welds. Qualification samples shall be welded at the Contractor or Subcontractor's facility using the procedures, consumables, and welding equipment that will be used for all welds performed during the Vehicle repair.

1.8.2.1 Backing material, if used, shall be the same as for welds performed during the Vehicle repair.

1.8.2.2 Weld qualifications shall include impact toughness testing performed using Charpy V-Notch specimens. Impact toughness in the weld heat affected zone (HAZ) shall be greater than 27J (20ft-lbs) at -30°C (-22°F).

1.8.2.3 Weld qualifications shall be recorded on a Procedure Qualification Record (PQR) providing the weld parameters used and results of all tests and inspections performed in support of the qualification.

1.8.2.4 The use of a WPS purchased from AWS or any other source is not permitted. Pre-qualification and use of pre-qualified welds and welding procedures is not acceptable.

1.8.3 All welders shall be qualified in accordance with the requirements AWS D1.1, D1.3, ASTM A488, or other Authority approved industry standard. Written welder qualification test records (WQTR) shall be made available for review at the Authority's request.

1.8.4 All WPS and PQR, along with specifications for purchase of welding consumables, shall be submitted for Authority approval prior to performing any welding on Authority owned equipment.

1.9 **Straightening**

1.9.1 Where possible, straightening shall be used to correct dimensional nonconformities. The Contractor shall be responsible for determining the applicability of cold or hot straightening and ensuring that straightening operations do not cause cracking, tearing, or other defects in the part being straightened.

1.9.1.1 Cold straightening shall be used to correct minor dimensional nonconformities only.

1.9.1.2 Hot straightening shall be used to correct larger dimensional nonconformities.

1.9.2 The following requirements apply to hot straightening:

1.9.2.1 The Contractor shall set maximum limits for straightening temperature, based on industry standards or testing performed by the Contractor, for each material that that will be hot straightened. The maximum straightening temperature shall not cause residual changes to the mechanical properties of the material being straightened. For quench and tempered materials, the straightening temperature shall not exceed the tempering temperature.

1.9.2.2 Temperature measurements shall be performed by means of contact or non-contact thermometers. If non-contact thermometers are used, calibration shall be performed at the maximum straightening temperature for each combination of material and surface finish.

1.9.2.3 If heating is applied using a torch, nozzles and heating technique shall be such that temperature gradients are limited, and heating is distributed across the part being straightened. Localized melting of the material surface shall not be permitted.

1.9.2.4 If heating is applied using a torch, the torch shall be adjusted for a neutral flame. Carburizing flames shall not be permitted.

1.9.2.5 All parts shall be cooled in still air following hot straightening. Forced cooling shall not be used.

1.9.3 After cold or hot straightening, the entire straightened part shall be visually inspected. Additionally, MT or PT shall be performed surrounding the locations of force application, mechanical fixation, and heat application, if used.

1.9.3.1 The locations of force application, mechanical fixation, and heat application shall be recorded, along with inspection results, and included in applicable History Books

1.9.3.2 If defects are found after straightening, the Authority shall be notified immediately and the Contractor shall develop a repair procedure. The repair procedure shall be submitted and approved by the Authority in writing prior to the Contractor starting repairs.

1.9.4 The Contractor shall submit a straightening procedure, including maximum temperature limits where applicable, for Authority approval prior to performing any straightening operations.

1.10 **Stress Relief Heat Treatment**

1.10.1 Local Heat Treatment

1.10.1.1 Truck frames shall be held securely during stress relief heat treatment to prevent distortion.

1.10.1.2 Heat treatment stress relief processes shall utilize equipment capable of accurately controlling, monitoring, and recording temperatures throughout the heat treatment area with the ability to calibrate for maximum accuracy.

1.10.1.3 Thermocouples shall be spot welded directly to the surfaces to be heat treated. If multiple areas will be heat treated simultaneously, at least one thermocouple shall be used at each location. The control system shall have a sufficient number of heating elements and temperature measuring devices to accurately measure and correct temperature deviations within the heat treatment area to ± 50°F for each process step.

1.10.1.4 Wrap the area to be heat treated with electric heating elements. Heating elements shall extend past the area to be heat treated equally in all directions to ensure uniform temperature across the area being heat treated.

1.10.1.5 Wrap the heating elements with an insulating blanket. Extend the insulating blanket past the heating elements equally in all directions to establish a gradient control band.

1.10.1.5.1 Where possible, insert insulation inside of closed sections to ensure uniform heating through the thickness of the shell around the closed section.

1.10.1.6 Heat treatment shall be performed as follows:

1.10.1.6.1 Ramp temperature from room temperature to between 1075°F and 1125°F at no more than 400°F per hour.

1.10.1.6.2 Hold between 1075°F and 1125°F for ½ hour.

1.10.1.6.3 Ramp temperature back to room temperature at no more than 300°F per hour.

1.10.1.7 Visual inspection and NDT surface inspection (MT or PT) shall be performed on all locally heat-treated areas.

1.10.1.8 A local heat-treating procedure shall be submitted for Authority review prior to heat treating any parts.

1.10.1.9 Temperature profiles from stress relief heat treatment shall be included by the Contractor as part of the applicable History Books.

1.10.1.10 Stress relief using a manual torch shall not be permitted.

1.10.2 Furnace Heat Treatment

1.10.2.1 Truck frames shall be held securely during stress relief heat treatment to prevent distortion.

1.10.2.2 The furnace shall utilize equipment capable of accurately controlling, monitoring, and recording temperatures throughout the heat treatment area with the ability to calibrate for maximum accuracy. The furnace temperature shall be controlled by the thermocouples spot welded to the part being heat treated, not by the air temperature in the furnace.

1.10.2.3 Thermocouples shall be spot welded directly to the surfaces to be heat treated. Multiple thermocouples shall be used per part to monitor the temperature distribution across the part.

1.10.2.4 Insert the part to be heat treated into the furnace at a location that ensures uniform heating of the part. If multiple parts are being heat treated simultaneously, they may not be stacked directly on top of one another.

1.10.2.5 Heat treatment shall be performed as follows:

1.10.2.5.1 Ramp temperature from room temperature to between 1075°F and 1125°F at no more than 400°F per hour.

1.10.2.5.2 Hold between 1075°F and 1125°F for ½ hour.

1.10.2.5.3 Ramp temperature back to room temperature at no more than 300°F per hour.

1.10.2.6 Visual inspection shall be performed on all furnace heat treated parts.

1.10.2.7 A furnace heat treating procedure shall be submitted for Authority review prior to heat treating any parts.

1.10.2.8 Temperature profiles from stress relief heat treatment shall be included by the Contractor as part of the applicable History Books.

1.11 Painting and Corrosion Protection

1.11.1 The Contractor is responsible for ensuring that all components have sufficient protection against corrosion under the expected service and environmental conditions. To demonstrate compliance with this requirement, the Contractor shall develop a Corrosion Protection Plan that incorporates all Specification and OEM requirements, along with general requirements for items not covered by the Specification or OEM documentation. The Corrosion Protection Plan shall be submitted for Authority approval and shall, at a minimum, include the following information.

1.11.1.1 Type of primer, paint, powder coat, sealant, anti-seize, plating, passivation, or other means of corrosion protection used for each component.

1.11.1.2 Technical and material safety data sheets for all primers, paints, sealants, anti-seize, or other chemicals used.

1.11.1.3 Coating, anti-seize, and sealant configuration, showing the application locations and types of coatings, anti-seize, and sealants used.

1.11.1.4 Procedures for each coating and sealant process, including surface preparation, temperature and humidity, coating thickness, and drying time requirements.

1.11.1.5 Record sheets for each coating and sealant process.

1.11.1.6 Coating and/or plating adhesion test results.

1.11.2 Unless otherwise required by this Specification or OEM documentation, exterior surfaces of the truck, bolster, and all truck-mounted or bolster-mounted components shall be coated using zinc chromate alkyd primer with compatible

black enamel, or Authority-approved alternate coating system. The coating system shall not conceal structural cracks that may develop in service.

1.11.2.1 Unless specifically noted otherwise, equipment mounting locations, bearing surfaces, clearance holes, threaded holes, ground pads, nameplates, and other areas that are at risk for embedment or wear particulate formation shall not be coated.

1.11.2.2 Prior to performing any coating process, surfaces not to be coated shall be masked or covered to prevent inadvertently coating the surface due to overspray or runs.

1.11.2.3 Prior to performing any coating, surfaces to be coated shall be cleaned of all oil, dirt, dust, and other foreign matter to a level necessary to meet the coating manufacturer's surface preparation requirements.

1.11.2.4 Coatings shall be applied as recommended by the manufacturer using the number of coats recommended by the manufacturer. Dry film thickness shall meet the manufacture's recommendations.

1.11.2.5 Coating adhesion shall be tested per the latest revision of ASTM D3359 on a sample of each combination of base material and coating system using the same surface finish and coating process that will be used for repairs. Adhesion shall achieve a maximum rating as provided by the coating manufacturer.

1.11.3 Sealant shall be applied per the OEM configuration, except that any additional areas deemed by the Contractor or Authority to pose a risk for water intrusion shall be sealed.

1.11.3.1 Prior to applying sealant, surfaces to be sealed shall be cleaned of all oil, dirt, dust, and other foreign matter to a level necessary to meet the sealant manufacturer's surface preparation requirements.

1.11.4 Joints between dissimilar metals shall be protected against galvanic corrosion by isolating the dissimilar metals using an Authority approved process.

1.11.5 Unless otherwise required by this Specification or OEM documentation, zinc plating shall be in conformance with ASTM B633 for service condition SC2, SC3, or SC4 with a Type II or Type VI finish.

1.11.5.1 Other plating processes may be submitted for Authority approval, provided they are able to withstand a minimum of 96 hours salt spray exposure without developing red rust or visible corrosion products. Salt spray testing shall be performed in accordance with ASTM B117.

1.11.6 Passivation or other means of corrosion protection shall be performed in accordance with an Authority approved industry standard.

1.12 **Grit Blasting**

1.12.1 Grit blasting shall be performed using non-destructive ceramic media such as ceramic beads, DuPont Star Blast, or other Authority-approved ceramic medium with rounded to sub-angular grains. Aluminum Oxide is not an acceptable grit blast medium.

1.12.2 Prior to grit blasting, all surfaces not to be blasted shall be protected to prevent damage from overspray.

1.12.2.1 Unless specifically noted otherwise, equipment mounting locations, bearing surfaces, clearance holes, threaded holes, ground pads, nameplates and other areas where a smooth surface finish is required shall not be grit blasted.

1.12.3 The Contractor shall submit a grit blasting procedure for Authority approval prior to grit blasting any parts.

1.13 **Cleaning and Stripping**

1.13.1 All repaired components shall be cleaned of oil, grease, dirt, dust, and other foreign matter.

1.13.2 Paint shall be stripped from repaired components as required by this Specification or the SMOM.

1.13.3 Cleaning and stripping may be achieved through chemical or mechanical means.

1.13.3.1 Where cleaning and stripping are achieved through mechanical means, care shall be taken not to damage the surface being cleaned or stripped. The final surface finish shall be in accordance with OEM requirements.

1.13.3.2 Where cleaning and stripping are achieved through chemical means, the chemical being used for cleaning or stripping shall be compatible with the surface being cleaned or stripped. Any nearby components that may be damaged by the cleaning or stripping chemicals shall be protected to prevent contact with the chemicals.

1.13.4 All surrounding locations that do not require cleaning or stripping shall be adequately protected during the cleaning and stripping operations.

1.13.5 Cleaning and stripping processes shall achieve cleanliness appropriate for the application.

1.13.5.1 For coating or sealant applications, cleanliness shall be in accordance with the coating or sealant manufacturer's recommendations.

1.13.5.2 For welding applications, cleanliness shall be in accordance with the applicable AWS code.

1.13.5.3 Cleanliness shall meet OEM requirements where available.

1.13.5.4 For other applications, cleanliness shall be in accordance with an Authority-approved SSPC or NACE standard.

1.13.6 The Contractor shall submit a Cleaning and Stripping Plan for Authority approval prior to cleaning or stripping any parts.

1.14 **Leak Testing**

1.14.1 Water Tightness Testing

1.14.1.1 Prior to performing the leak test, the hydraulic system shall be filled with hydraulic fluid and bled to remove any air within the system.

1.14.1.2 After making repairs, the entire leak test shall be repeated to verify that repair work did not cause any additional leaks.

1.14.1.3 The Contractor shall submit a procedure for pneumatic system leak testing as needed, including test pressures and acceptance criteria, for Authority review and approval.

1.15 **Dimensional Inspection**

1.15.1 Dimensional inspections shall be performed by qualified personnel using tools with sufficient accuracy and precision to identify conforming and nonconforming components. Inspection tools shall be kept in current calibration.

1.15.2 Dimensional inspection acceptance/rejection criteria shall be in accordance with the OEM requirements. At a minimum, the following items shall be inspected:

1.15.2.1 Where specified, surface finish, flatness, and profile shall be inspected.

1.15.2.2 Clearance holes for equipment mounting shall be inspected for diameter and circularity.

1.15.2.3 Machined bores, bosses/pins, and guide shafts shall be inspected for diameter, depth/length, circularity, concentricity, and surface finish.

1.15.2.4 Rotating shafts shall be inspected for diameter and runout.

1.15.2.5 Threaded holes and bosses shall be inspected for damaged, oversized, or undersized threads using go/no-go gauges. Unless otherwise specified by

the OEM, threaded holes and bosses shall conform to the dimensional requirements of ASME B1.1, Class 2.

1.15.2.6 Where specified or included on OEM drawings, parallelism, perpendicularity, and concentricity shall be inspected.

1.15.2.7 Dimensional inspection shall check for bent or distorted components.

1.15.3 Procedures calling for dimensional inspection shall show the dimension to be measured, list the tool to be used for inspection, and provide nominal, minimum acceptable, and maximum acceptable values for each dimensional measurement.

1.15.4 The results of all dimensional measurements shall be recorded in the applicable History Books provided by the Contractor.

1.16 **Electrical Wiring**

1.16.1 All wiring shall be performed by qualified, experienced wiring personnel using appropriate tools for stripping insulation, cutting, tinning, soldering, harness making, attaching terminals, and other wire fabrication tasks.

1.16.2 Wire shall be protected from damage during all phases of equipment manufacture.

1.16.2.1 Wire shall not be walked on, dragged across sharp or abrasive objects, kinked or twisted, or otherwise mishandled.

1.16.2.2 The ends of wire shall not be permitted to lay on wet floors or other damp areas where moisture may be absorbed into the conductors.

1.16.3 There shall be no nicks in the insulation of any wire or cable.

1.16.3.1 Wire and cable with nicked or otherwise damaged insulation shall be replaced.

1.16.3.2 In isolated cases, a repair procedure may be proposed in lieu of replacement, subject to review and approval of the Authority. Such approval will not be granted for Teflon-based insulation or where the depth of the nick is greater than 50 percent of the insulation thickness.

1.16.4 When removing insulation, wire strands shall not be nicked or broken in excess of the limits of FAA Specification No. AC 43.13-1A, Section 449, “Stripping Insulation.” Additionally, the following criteria shall apply:

1.16.4.1 Wires smaller than AWG No.10 shall have no nicked or broken strands.

1.16.4.2 AWG No.10 through AWG 1/0 shall be allowed 7.4 percent nicked strands.

1.16.4.3 Above AWG 1/0 through 1600/24 shall be allowed 4.4 percent nicked strands.

1.16.4.4 Above AWG 1600/24, nicked strands shall be allowed on a graduated scale.

1.16.4.5 Definitions: A broken strand shall count as two nicked strands. A nick is defined as 25 percent or more of the strand area damaged or cut more than 33 percent of its diameter. Longitudinal scratches in a copper strand are not considered cause for rejection.

1.16.5 Cable conductors shall be clean prior to installation of terminals, lugs, or connectors.

1.16.6 Terminals, lugs, and connectors shall be attached to the wiring using the proper crimping tools and dies recommended by the manufacturer. Only one wire shall be crimped in any one terminal.

1.16.6.1 Swaging tools shall be of a type that ensures complete swaging in every case.

1.16.7 If used, solder shall be in accordance with ASTM B32, Grade Sn60. A non-corrosive flux shall be applied immediately before soldering.

1.16.8 All terminals shall be properly torqued to assure sound connections.

1.16.9 Conductors which may be subjected to motion relative to the terminal shall be protected by suitable means to prevent breakage of the conductor at or near the terminal.

1.16.10 Wires and cables shall not be allowed to chafe or rub against any part of the truck, wireway, conduit, or each other.

1.16.11 Wire and cable dress shall allow for sufficient slack at equipment terminals to provide for movement induced by shock and vibration, equipment shifting, alignment, cover removal, and component replacement.

1.16.12 A drip loop shall be provided on all exposed wires and cables to prevent fluid runoff into connected equipment.

1.16.13 Pulling compound, is used, shall be non-conductive, non-hygroscopic, non-odorous, shall not support bacterial activity, nor attract vermin.

1.16.14 Electrical tape shall not be PVC. Electrical tape shall meet or exceed the voltage rating of wire where the tape is applied.

1.16.15 An anti-corrosive grease shall be applied to the contacting surfaces of all ground connections.

1.16.16 Wire-tying devices shall be of such material and construction that they will adequately retain the wires for the life of the wiring and shall be resistant to ozone and ultraviolet light.

1.16.16.1 Wire and cable ties shall be trimmed and located to eliminate any hazard to personnel or risk of chafing/cutting adjacent wires due to sharp edges.

1.16.16.2 Wire-tying devices shall be snug but shall not be so tight as to cause indentation and cold flow damage to insulation.

1.16.16.3 Wire-tying devices shall be mechanically fastened to a permanent structure. Adhesive-installed mounting bases shall not be used for ties or for cable support.

1.17 Electrical Testing

1.17.1 General

1.17.1.1 The Contractor shall submit an electrical testing procedure, including acceptance criteria and test voltage/time, for Authority review and approval.

1.17.2 Wiring Continuity

1.17.2.1 All circuits shall be tested to ensure continuity and correct polarity of equipment and devices. All frame grounds and terminal connections shall be checked for tightness.

1.17.3 Insulation Resistance

1.17.3.1 Insulation resistance tests shall be conducted on all electrical wiring and connections. Tests shall be conducted to verify the state of the insulation to the case or frame.

1.17.3.2 The following insulation resistance limits shall apply when all circuits of a given voltage class are connected in parallel under all environmental conditions, including high humidity. Measurements shall be taken after applying constant voltage for 1 minute.

1.17.3.2.1 Where the nominal circuit voltage is below 90 V, the minimum insulation resistance shall be 2 megohm at 500 Vdc.

1.17.3.2.2 Where the nominal circuit voltage is 90 to 300 V, the minimum insulation resistance shall be 4 megohm at 1000 Vdc.

1.17.3.2.3 Where the nominal circuit voltage is above 300 V, the minimum insulation resistance shall be 5 megohm at 1000 Vdc.

1.17.4 High Potential Tests

1.17.4.1 High potential tests shall be conducted only once the insulation resistance tests are completed and passed. Tests shall be conducted to verify the state of the insulation to the case or frame.

1.17.4.2 The test shall be conducted by applying the test voltage, as listed below, for a period of 1 minute, across the insulation being tested. The test is passed if there is no insulation breakdown or excessive leakage current. The test voltage shall be at a frequency of 50 or 60 Hz with a sinusoidal waveform. Alternatively, the test voltage can be dc with a value equal to 1.414 times the ac rms voltage. In the formula below, V shall be the nominal system voltage for a circuit.

1.17.4.2.1 If the nominal circuit voltage is below 300 V, the test voltage shall be 2*V + 1000 Volts.

1.17.4.2.2 If the nominal circuit voltage is equal to or above 300 V, the test voltage shall be 2.25*V + 2000 Volts.

END OF DOCUMENT